

LETTERS TO THE EDITOR.

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Production of Radium from Actinium.

In a recent letter to this Journal (November 15, 1906) Dr. Boltwood has given an account of experiments which show that radium is continuously produced in a solution of actinium, and concludes that radium is a disintegration product of actinium, the latter occupying an intermediate position in the family of disintegration products between uranium and radium. The radium is produced from the actinium at about the theoretical rate, and he deduces in a simple way that the time for radium to be half transformed is about 3000 years. These results of Dr. Boltwood are of great interest, and mark an important stage in the search for the somewhat elusive parent of radium.

It may be of interest to the readers of NATURE to give a brief account of some experiments I have made on this subject, the results of which were communicated to the American Physical Society at New York on December 28, 1906. In the Bakerian lecture of 1904 (Phil. Trans., A, p. 169, 1904) I briefly described some experiments that had been commenced to see whether actinium produced radium. Some of Giesel's actinium was taken, dissolved in acid, and the greater part of the radium then present was removed by precipitating barium in the solution. The amount of radium left in the solution was determined by the emanation method, using an electroscope carefully calibrated by means of a standard radium solution. Over a period of three months no very certain evidence was obtained that the amount of radium had increased. The solution of actinium was then set aside in a closed vessel with the intention of testing it for the presence of radium at regular intervals. In the meantime, the great danger of possible contamination, in testing solutions for radium in a laboratory where considerable quantities of radium were continually in use, was recognised, and for this and other reasons the solution was not again tested until two and a half years had elapsed.

When Dr. Boltwood informed me of the growth of radium in his actinium, I at once tested this solution for radium by the emanation method. A preliminary observation showed that there had been a large increase in the quantity of radium in the solution in the interval since the early experiments. In the course of making an accurate determination, the solution was unfortunately contaminated with radium, probably through the use of a lubricant on a stop-cock attached to the vessel. Under such conditions I could place no reliance on the final measurement. Happily, however, I had placed aside, at the time of preparing the original actinium solution, a sample of the actinium salt the radium content of which at that time had been accurately determined. This was now tested, and the amount of radium in it was found to have increased at least four times the initial value in the two and a half years' interval, showing a rate of growth of radium in the actinium of much the same magnitude as that observed in the experiments recorded later. I think that my failure to observe an increase in the amount of radium in the actinium solution over a period of three months was due to the unsuitable chemical treatment used initially to remove the radium from the actinium. An excess of sulphuric acid must have remained in the solution, and this would tend to precipitate the radium when formed as sulphate—a condition in which probably only a fraction of the emanation would be released. A considerable increase in the amount of radium might consequently only show a small increase in the amount of emanation carried away by aspirating air through the solution.

Experiments were at once undertaken to remove the radium again from the contaminated solution by a simpler and better method. This proved successful, and only a minute fraction of the radium was left in the solution. The latter was then placed in a glass vessel, and the

amount of radium in it determined weekly by boiling out the emanation, and then introducing it into a suitable emanation electroscope. A progressive increase in the amount of radium has been observed, amounting to 80 per cent. of the initial value over a period of five weeks. If this rate of growth continues at a constant rate, the amount of radium in the solution at the end of a year should be more than eight times the initial value. The actinium used in this experiment was equivalent to about half a gram of an actinium preparation of activity about 250 times uranium, and the rate of growth of radium observed corresponds to about 3×10^{-9} gram of radium per year.

There is one important point that suggests itself in considering the results as given by Dr. Boltwood. The growth of radium observed in his actinium solution possibly might arise, not from the actinium itself, but from another distinct substance, normally separated from the radio-active mineral with the actinium. In order to throw some light on this question, I compared the rate of production of radium observed in my actinium with the rate of production to be expected on the simple theory, supposing that the actinium is transformed directly into radium. Without going into details, it suffices to say that this can be done by comparing the α -ray activity of a known fraction of the actinium solution in the form of a very thin film with that of a thin film containing a known quantity of radium. In this way I calculated that the growth of radium observed agreed with the disintegration theory, if the period of half transformation of radium was about 2600 years. The period so deduced is not very different from that determined by Boltwood from quite distinct considerations. This is satisfactory so far as it goes, but such an agreement between the periods obtained by the two methods implies that the activity, due to the actinium in pitchblende, is about the same as that due to radium and its products. As a result of careful measurements, Boltwood, however, found that this is not the case, for the activity due to the actinium is only a small fraction of that due to radium. Further experiments are required to explain this anomaly.

There is one other point on which I have made a number of experiments. If radium arises from actinium, it should be produced by the active deposit of actinium which contains the last products of the actinium series, namely, actinium A and B. In order to test this, a platinum plate was made the negative electrode in a vessel containing a very active actinium preparation, and the active deposit was collected for a week or more. The platinum plate was then removed and immersed in a closed vessel containing dilute hydrochloric acid. After standing for a week, the accumulated emanation was boiled out, and the amount determined in an electroscope. Knowing the amount of the α -ray activity due to the active deposit on the platinum plate compared with the activity due to a thin film of radium, and also the time of exposure, it is a simple matter to calculate the growth of radium to be expected on the assumption that radium is half transformed in about 3000 years. Using a small platinum plate, the amount of radium observed was certainly not greater than one-tenth the theoretical amount, and, with a much larger plate, not more than one-fifth. In these experiments the greatest care was taken to avoid any possible radium contamination. The observations were made in the chemistry building which is free from radio-active material, and I was fortunate in having the use of the emanation electroscopes of low natural leak, set up by Mr. Eve, who kindly assisted me in these experiments. The plates and solutions employed were initially tested for the presence of radium, so that the growth of radium observed, though much smaller than the theoretical amount, was still quite definite. These experiments are being continued. The smallness of the amount of radium observed may either be due to the presence of another change between actinium B and radium, or, what is more probable, to the loss in an electric field of the radium formed on the platinum plate. Such a possibility is suggested by the results of Meyer and Schweidler, who observed that there was always a small residual activity on substances, exposed for a long time in the presence of the actinium emanation, which gradually disappeared.

Further experiments are in progress to examine in the early stages the growth of radium in actinium, initially freed from radio-actinium and all its products. If actinium changes directly into radium, the initial growth of the radium should be much smaller than that to be obtained three months later, when the products are in approximate equilibrium.

The results of my experiments are thus substantially in agreement with those of Dr. Boltwood. There is no doubt that the immediate parent of radium is present in actinium separated from pitchblende, but certain points remain to be settled before it is definitely proved that radium is the direct lineal descendant of actinium. Since the proof of this relationship between actinium and radium involves many important theoretical consequences, I think it is advisable to await the results of further experiment in this direction before basing far-reaching conclusions upon it.

E. RUTHERFORD.

McGill University, Montreal, January 3.

Helium and Argon in Common Rocks.

THE quantity of radium found in granites and kindred rocks (Proc. Roy. Soc., A, vol. lxxvii., p. 472), about 10^{-11} grams per c.c., suggested that the associated helium might be present in sufficient quantity for spectroscopic detection. This has proved to be the case. Thus 250 grams of Matopo granite yielded 3 c.c. of nitrogen on heating. This nitrogen, on sparking down, gave a residue of about $1/100$ th part of its own volume. The residue was introduced into a vacuum tube, and showed the spectra of argon and helium quite brilliantly, and in about equal intensity. Similar results were obtained with syenite rocks from Mt. Sorrel in Leicestershire, and from Norway.

It seems more than probable that these observations afford an explanation of the nature of the gases evolved by mineral springs. The invariable presence of a notable quantity of helium in such gases has always been considered remarkable. It would seem that it may be sufficiently explained by the action of hot water in disintegrating common rocks and liberating the gases contained.

It is my intention to examine a large selection of common rocks and minerals, and particularly with the view of determining whether helium in them is always associated with radium, or whether its presence can ever be attributed to radio-activity of ordinary materials.

R. J. STRUTT.

Sunnyside, Cambridge, January 13.

Ionisation and Absorption and Anomalous Dispersion.

DR. STARK (NATURE, vol. lxxiii., pp. 78, 389, 533) has given a theory, based on his canal-ray experiments, according to which spectrum series are due to positive ions. It occurred to me that its applicability to thermal emission might be tested by experiments on the ionisation accompanying the anomalous dispersion in sodium vapour. Accordingly, together with Mr. Needham, I made some preliminary experiments, using a slight modification of Prof. Wood's well-known apparatus ("Physical Optics," p. 340), of which the results seem to be of sufficient interest to deserve publication.

We used a steel tube, 40 cm. long, with an insulated iron wire stretched inside and along it about 1 cm. from the sodium surface. The poles of a battery were connected to the wire and tube through a liquid resistance and galvanometer (1 division = 10^{-8} ampere about); the tube was placed between the collimator and grating of a spectroscope, and the image of a horizontal fine wire stretched across the slit was observed in the first spectrum with a micrometer eye-piece. The separation, due to anomalous dispersion, of the two halves of the image on opposite sides of the absorption band was assumed to be a sufficient measure of the anomalous dispersion.

Curves constructed from observations of anomalous dispersion and current show that every variation of the ionisation, due to some irregularity of pressure and temperature, is accompanied by a corresponding variation in the anomalous dispersion.

The simplest explanation of the parallelism between the

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curves is that the D lines of sodium are due to positive ions rather than to neutral atoms, in accordance with Stark's theory.

G. A. SCHOTT.

Physical Laboratory, University College of Wales,
Aberystwyth, December 20, 1906.

THE MILLAIS BRITISH MAMMALS.¹

WITH the appearance of this volume we have the pleasure of congratulating the author on the completion of a very heavy task. As we have had occasion to remark in our notices of the two earlier volumes, from the point of view of pictorial illustration the work is in the main all that can be desired, and there is little doubt that in this respect it will long remain absolutely without a rival. Our very heartiest congratulations may accordingly be tendered to Mr. Millais and his fellow artists on the result of their endeavours to illustrate in an adequate and exhaustive manner the living and recently exterminated mammals of the British Isles. In giving as the

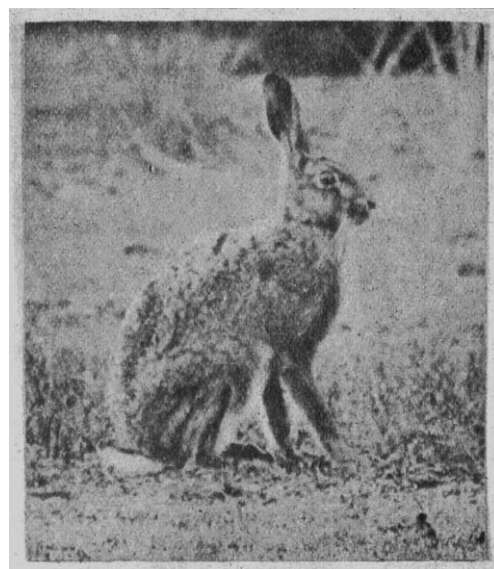


FIG. 1.—The Hare. From "The Mammals of Great Britain and Ireland."

frontispiece of the present volume a picture of a southern right-whale attacked by a party of grampuses, or killers, it may possibly be objected that the author has introduced a scene which cannot now be witnessed in British waters. Since, however, the past as well as the present state of the fauna of our islands enters into the purview of the work, there may be justification for such an illustration; and even if this be not the case, the privileges of artistic license may be pleaded as sufficient excuse. Had space been available, we should have had much pleasure in reproducing one of the full-page illustrations which form by far the most striking feature of the work. Failing this, we have to be content in presenting to our readers (by the courtesy of the publishers) three of the smaller illustrations as examples of the pictorial merit of the work.

The groups included in the present volume comprise the hares and rabbit; the ungulates, of which (if we exclude the white park-cattle, which are obviously not wild animals) the red deer, the fallow deer, and

¹ "The Mammals of Great Britain and Ireland." By J. G. Millais. Vol. iii. Pp. xii+384; illustrated. (London: Longmans, Green and Co., 1906.) Price 67. 6s. net.